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## Risk factors for relapse to problem drinking among current and former US military personnel: A prospective study of the Millennium Cohort<sup>☆</sup>

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### ABSTRACT

**Background:** Military service members may be prone to relapse to problem drinking after remission, given a culture of alcohol use as a coping mechanism for stressful or traumatic events associated with military duties or exposures. However, the prevalence and correlates of relapse are unknown. We sought to identify socio-demographic, military, behavioral, and health characteristics associated with relapse among current and former military members with remittent problem drinking.

**Methods:** Participants in the longitudinal Millennium Cohort Study who reported problem drinking at baseline (2001–2003) and were remittent at first follow-up (2004–2006) were included ( $n=6909$ ). Logistic regression models identified demographic, military service, behavioral, and health characteristics that predicted relapse (report of  $\geq 1$  past-year alcohol-related problem on the validated Patient Health Questionnaire) at the second follow-up (2007–2008).

**Results:** Sixteen percent of those with remittent problem drinking relapsed. Reserve/National Guard members compared with active-duty members (odds ratio [OR] = 1.71, 95% confidence interval [CI]: 1.45–2.01), members separated from the military during follow-up (OR = 1.46, 95% CI: 1.16–1.83), and deployers who reported combat exposure (OR = 1.32, 95% CI: 1.07–1.62, relative to non-deployers) were significantly more likely to relapse. Those with multiple deployments were significantly less likely to relapse (OR = 0.73, 95% CI: 0.58–0.92). Behavioral factors and mental health conditions also predicted relapse.

**Conclusion:** Relapse was common and associated with military and non-military factors. Targeted intervention to prevent relapse may be indicated for military personnel in particular subgroups, such as Reservists, veterans, and those who deploy with combat exposure.

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## 1. Introduction

Alcohol use is the third-greatest contributor to morbidity and mortality in the United States (Mokdad et al., 2004) and comes at enormous cost to society (Harwood et al., 1998, 2009). While many people drink alcohol at healthy levels, approximately 9% drink at levels that result in the development of problems (e.g., familial or legal problems; Grant et al., 2004). Once people drink at these levels, they often have a hard time changing despite experiencing resultant problems. While some people with problem drinking can resolve problems with or without stopping all use, many cannot (Dawson et al., 2007; National Center on Addiction and Substance Abuse, 2012). Therefore, problem drinking can be considered a chronic condition (McLellan et al., 2000) that relapses and remits such that people move in and out of problem drinking separated by intervals of abstinence, risky drinking, or use at recommended levels (Dawson et al., 2007; Vaillant, 1983; Vaillant and Milofsky, 1982).

Multiple studies have described high rates of problem drinking among military service members (Armed Forces Surveillance Center, 2013; Bray et al., 2013, 2010; Clarke-Walper et al., 2013; Heltemes et al., 2013; Institute of Medicine, 2012; Jacobson et al., 2008; Stahre et al., 2009). Problem drinking may be particularly costly in this population due to associated decreased work performance (Blume et al., 2010; Frone, 2006; Harwood et al., 2009), impaired athletic performance (O'Brien and Lyons, 2000), increased risk of injury (Harris et al., 2009; Williams et al., 2012) and comorbid mental health disorders (Bray et al., 2010; LeardMann et al., 2013), and multiple other adverse health outcomes including sleep deprivation and fatigue (Lamond and Dawson, 1999; Roth and Roehrs, 1996) that may lead to performance impairment (Harwood et al., 2009; Institute of Medicine, 2012). The costs of alcohol use to the Department of Defense (DoD) were recently estimated at \$425 million per year (Dall et al., 2007; Institute of Medicine, 2012).

Military service members may be prone to relapse after previous recovery periods, given a culture of alcohol use as a coping mechanism for stressful or traumatic events associated with military duties or combat exposure (Ames and Cunradi, 2004; Ames et al., 2007, 2009; Institute of Medicine, 2012). However, the prevalence and unique predictors of relapse are unknown in military personnel for whom the experiences within the military may significantly influence relapse (Ames et al., 2007).

We sought to describe the prevalence of relapse to problem drinking, as well as to identify sociodemographic, military, behavioral, and health characteristics associated with relapse, among current and former military members with remittent problem drinking in a large, prospective study of US military service members who participated in The Millennium Cohort Study.

## 2. Methods

### 2.1. Study population and data sources

The Millennium Cohort Study commenced prior to September 11, 2001, and consists of four recruitment panels that are surveyed approximately every 3 years. The present study utilized data from the first recruitment panel, a weighted sample of active duty and Reserve/National Guard personnel serving in the military as of October 2000. Personnel deployed to Southwest Asia, Bosnia, and Kosovo from 1998 to 2000, Reservists, and women were oversampled. Informed consent was obtained from all participants. Detailed description of the sampling and methodology has been previously published (Ryan et al., 2007; Smith et al., 2007). This study was reviewed and approved by IRBs at the Naval Health Research Center and VA Puget Sound.

Data sources included questionnaires and official military records. Electronic military personnel files provided by the Defense Manpower Data Center (DMDC) contained sociodemographic, military service, and employment characteristics. Behavioral metrics and military exposures, including alcohol use and combat experience, were obtained from the questionnaires.

**Inclusion and exclusion criteria:** Of the 77,047 participants (36% of those initially contacted; Ryan et al., 2007) enrolled in the first panel, 46,437 participants

completed a baseline questionnaire (Wave 1) and two consecutive follow-up surveys (Wave 2: 2004–2006 and Wave 3: 2007–2008). The baseline Millennium Cohort survey instrument included a skip pattern such that participants who did not endorse drinking more than 12 alcohol beverages in the last year were asked to skip the remaining alcohol-related questions. Therefore, completion of all three surveys as well as report of drinking more than 12 alcoholic beverages in the last year were considered initial inclusion criteria. Participants additionally had to (1) respond to questions pertaining to "problem drinking" at baseline, (2) be in remittance from problem drinking at Wave 2 and thus at risk for relapse, and (3) have complete data on exposures and problem drinking status in order to be eligible for this study (Fig. 1). There were 6909 participants who met these criteria.

### 2.2. Problem drinking

Baseline problem drinking was assessed using the lifetime version of the CAGE questionnaire (Ewing, 1984; Have you ever felt the need to cut down your drinking, felt annoyed by criticism of your drinking, had guilty feelings about drinking, taken a morning eye opener?) and the PRIME-MD Patient Health Questionnaire (PHQ), which assesses five alcohol-related consequences occurring more than once during the last 12 months (Spitzer et al., 1999). PHQ alcohol-related items include (1) drinking alcohol even though a doctor suggested stopping because of health problems; (2) being high from alcohol or hung over while working, being in school, or taking care of children; (3) missing or being late for work, school, or other activities because of drinking; (4) having problems getting along with people while drinking; and (5) driving a car after having several drinks or after drinking too much. Baseline problem drinking was defined as endorsement of one or more items from either the CAGE or PHQ. Remittent problem drinking was defined based on non-endorsement of any PHQ item at the Wave 2 survey. The study outcome, relapse to problem drinking, was defined based on endorsement of any PHQ item at Wave 3. The CAGE was not used to define problem drinking at Waves 2 or 3 due to its lifetime time frame.

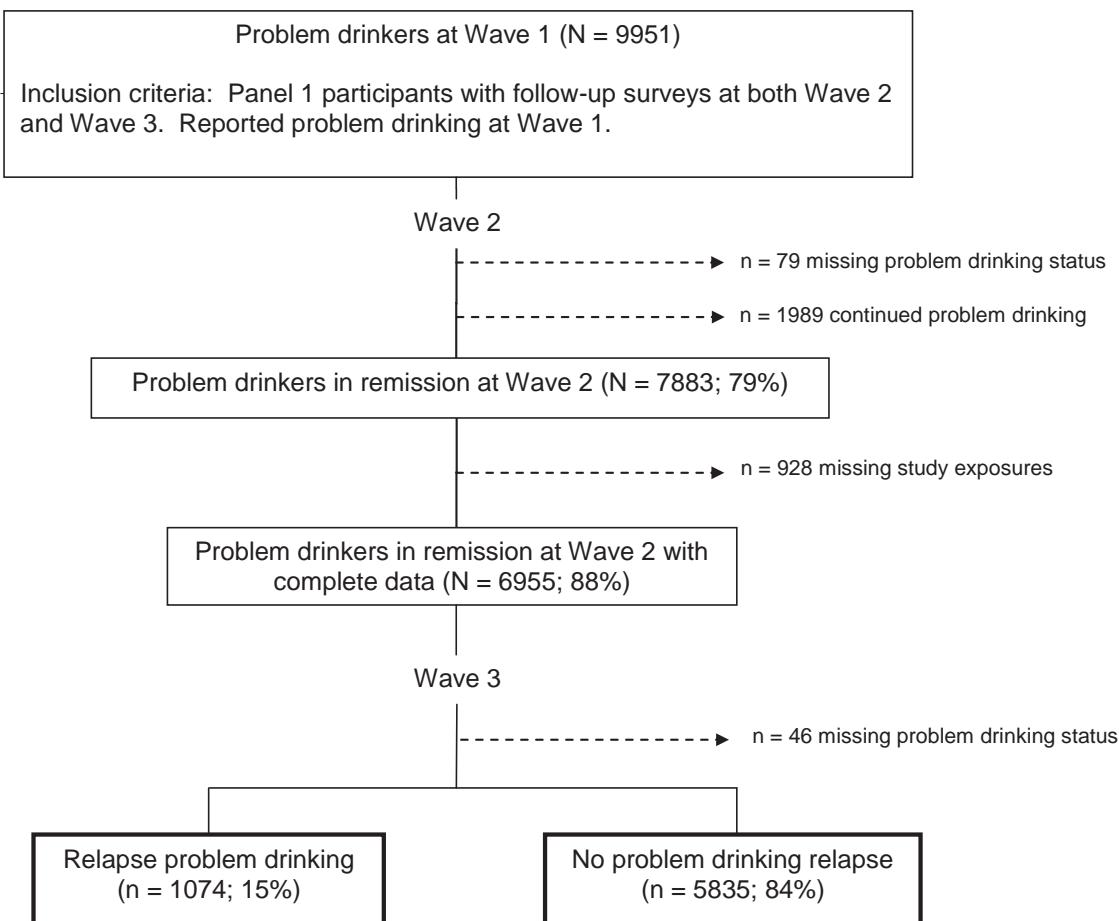
### 2.3. Exposures

**Demographic characteristics:** Demographic characteristics included sex, age (17–24, 25–34, 35–44, and >44 years), marital status (never married, married, divorced or widowed), education (some college or less, bachelor's degree or higher), and self-reported race/ethnicity (white non-Hispanic, black non-Hispanic, Hispanic, and other). Asian and Native American participants, as well as those of unknown race, were included in the "Other" group due to small numbers. All characteristics except marital status were obtained at baseline; marital status was obtained at Wave 2 because it may vary over time.

**Military service characteristics:** Military characteristics included service branch (Army, Navy/Coast Guard, Marine Corps, Air Force), service component (active duty, Reserve/National Guard), occupation (combat specialist, health care, other) and pay grade (junior enlisted [E00–E05], senior enlisted [E06–E09], officer [warrant and enlisted]). Deployment experience was obtained between Waves 1 and 2 and categorized as no deployment, deployment without combat exposure, and deployment with combat exposure. Combat exposure was assessed using 5 items that asked "over the past 3 years" whether respondents had personally: (1) witnessed a death due to war, disaster, or tragic event; (2) witnessed instances of physical abuse; (3) exposed to dead or decomposing bodies; (4) exposed to maimed soldiers or civilians; or (5) exposed to prisoners of war or refugees. Endorsement of any item was combined with deployment dates to identify deployment with combat exposure. Deployment to Southwest Asia, Bosnia or Kosovo before 2000 (yes/no), multiple deployments (yes/no), and military separation during 2001–2008 were evaluated using DMDC data.

**Behavioral factors:** Three behavioral factors were measured at Wave 2. Smoking status was categorized into non-smoker, past smoker, or current smoker. Non-smokers reported never having smoked 100 cigarettes at Wave 1 and Wave 2 surveys. Current smokers reported smoking 100 cigarettes ever and had not tried or had been unsuccessful at quitting at Wave 2. Past smokers reported smoking 100 cigarettes ever and having successfully quit at consecutive waves (1 and 2) or at Wave 2. Drinking status at Wave 2 was defined based on past-week and past-year items measuring the quantity and frequency of average drinking and the frequency of heavy episodic (or "binge") drinking reported at Wave 2. Abstinence was defined as reporting zero drinks in the last week and never binge drinking ( $\geq 5$  and  $\geq 4$  drinks/day for men and women, respectively, on a single occasion) in the last year. Low-risk drinking was defined as alcohol use within national recommended weekly limits (National Institute on Alcohol Abuse and Alcoholism, 2007;  $\leq 7$  drinks for women and  $\leq 14$  drinks for men) and no report of binge drinking. Risky drinking was defined as exceeding the recommended weekly or daily limits, or any binge drinking in the last year (Smith et al., 2009). Trouble sleeping was defined based on a response of "moderately" or "greatly" to the question "In the past month, have you had trouble falling asleep or staying asleep?" on the Posttraumatic Stress Disorder (PTSD) Checklist-Civilian Version (PCL-C); or a response of "several days or longer" to the question "Over the last 4 weeks, how often have you experienced trouble falling asleep or staying asleep?" on the PHQ.

**Mental health conditions:** Depression, anxiety, and panic disorders were assessed at Wave 2 using the PHQ, based on *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) criteria (Kroenke et al., 2001; Spitzer et al., 1999).



**Fig. 1.** Flow chart for study population.

Binge eating was defined as self-report indicating a loss of control over eating and consuming unusually large amounts of food, or excessive exercise to avoid gaining weight (Striegel-Moore et al., 2010). PTSD symptoms were measured using the PCL-C and were defined based on (1) meeting DSM-IV criteria of reporting at least three avoidance symptoms, two hyperarousal symptoms, and one intrusion symptom at "moderate" or higher levels, and (2) having a total score of  $\geq 50$ . The PCL has been shown to correctly identify individuals with PTSD based on symptom reporting (sensitivity 100%, specificity 92%) and the 50 point cut-off (sensitivity 60%, specificity 99%) (Blanchard et al., 1996; Brewin, 2005). Due to small numbers, a single measure indicating any mental health condition at Wave 2 was created to represent screening positive for depression, binge eating, anxiety, panic, or PTSD.

**Physical health:** Physical health was measured at Wave 2 by the physical component summary (PCS) score derived from the Medical Outcomes Study Short Form 36-Item Health Survey for Veterans (McHorney et al., 1993; Ware et al., 1998). PCS scores range from 1 to 100, with 100 representing optimal health, and are standardized to the US population (mean score 50; SD = 10) (Ware et al., 1993). Because military personnel generally have very good physical health, PCS scores were divided into three percentile groups (1–15, 16–85, and 86–100).

**Life stressors:** Life stressors (0, 1, >1) assessed at Wave 2 included divorce, major financial problems, sexual harassment, violent assault, death or illness of a loved one, or personally experiencing a disabling illness or injury in the last 3 years, as well as report of forced sexual relations or sexual assault (yes/no) (Holmes et al., 1967).

#### 2.4. Statistical analysis

In order to assess differences by loss to follow-up, initial analyses described and compared exposure characteristics across two groups: (1) initial Millennium Cohort participants with remittent problem drinking at Wave 2 who did not respond to Wave 3 and, (2) the eligible study population (i.e., those with remittent problem drinking at Wave 2 who responded to Wave 3). Subsequently, characteristics of the included sample were described and compared across problem drinking relapse status. All comparisons were completed with Chi Square tests of independence, and all descriptive analyses were weighted to account for sampling strategy (Korn and Graubard, 1999).

Three sets of iteratively adjusted logistic regression models were fit to estimate the odds of relapse associated with each exposure. All models were adjusted for prior deployment, service component, and gender to account for oversampling of specific military subpopulations (Korn and Graubard, 1999). The first set of models was additionally adjusted for remaining demographics and drinking status at Wave 2 due to known strong associations between relapse and these characteristics (Dawson et al., 2007). In order to understand the extent to which military-specific exposures attenuated observed associations, the second set of models additionally included all military characteristics. The final model was considered the primary analytic model and included all exposure characteristics, thus obtaining estimates for each exposure characteristic adjusted for all other exposures. Collinearity was evaluated with the variance inflation factor (VIF); no problems were likely (VIF < 4 in all instances). All analyses were performed with SAS software, version 9.3 (SAS Institute Inc., Cary, North Carolina).

## 3. Results

Analyses assessing response bias identified small but significant differences in all characteristics, except gender, combat deployment, deployment to Southwest Asia, Bosnia or Kosovo before 2000, and report of binge eating or sexual assault (Supplementary Table<sup>1</sup>).

Weighted distributions of exposure characteristics in those who relapsed to problem drinking, those who did not relapse, and for the total population, are presented in Table 1. Among 6909 participants with remittent problem drinking, 1074 (16%) relapsed during the subsequent 3 years. Weighted distributions of all characteristics except gender, race, occupation, military separation, PCS scores, and report of sexual assault were statistically

<sup>1</sup> Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi:...

**Table 1**Characteristics<sup>a</sup> of weighted<sup>b</sup> study population: overall and by problem drinking relapse status.

	Relapsed to problem drinking* N (%)	Remission** N (%)	Total N (%)	p-Value <sup>c</sup>
<b>N</b>	1074 (16)	5835 (84)	6,909	
<b>Demographics</b>				
<i>Sex</i>				0.10
Female	190 (14)	1125 (86)	1315	
Male	884 (16)	4710 (84)	5594	
<i>Race/ethnicity</i>				0.11
White, non-Hispanic	832 (16)	4463 (84)	5295	
Black, non-Hispanic	71 (13)	481 (87)	552	
Hispanic	74 (20)	315 (80)	389	
other	97 (15)	576 (85)	673	
<i>Age category (years)</i>				<0.01
17–24	203 (20)	856 (80)	1059	
25–34	386 (16)	2102 (84)	2488	
35–44	357 (16)	2003 (84)	2360	
>44	128 (13)	874 (87)	1002	
<i>Marital status</i>				<0.01
Married	711 (15)	4220 (85)	4931	
Never married	260 (20)	1103 (80)	1363	
Divorced or widowed	103 (18)	512 (82)	615	
<i>Education</i>				<0.01
Bachelor's degree or higher	267 (13)	1854 (87)	2121	
Some college or less	807 (17)	3981 (83)	4788	
<b>Military service</b>				
<i>Service branch</i>				<0.01
Army	577 (18)	2683 (82)	3260	
Navy/Coast Guard	221 (15)	1294 (85)	1515	
Marines	71 (21)	294 (79)	365	
Air Force	205 (11)	1564 (89)	1769	
<i>Service component</i>				<0.01
Active duty	527 (14)	3293 (86)	3820	
Reserve/Guard	547 (18)	2542 (82)	3089	
<i>Occupation</i>				0.19
Combat specialist	264 (16)	1386 (84)	1650	
Health care	93 (13)	541 (87)	634	
Other	717 (16)	3908 (84)	4625	
<i>Pay grade</i>				<0.01
Junior enlisted	485 (19)	2219 (81)	2704	
Senior enlisted	350 (16)	1911 (84)	2261	
Officer	239 (13)	1705 (87)	1944	
<i>Combat deployment prior to Wave 2</i>				0.02
Not deployed	756 (16)	4128 (84)	4884	
Deployed without combat exposure	116 (13)	827 (87)	943	
Deployed with combat exposure	202 (19)	880 (81)	1082	
<i>Multiple deployments between Waves 1–3</i>	155 (14)	1065 (86)	1220	0.03
<i>Military separation over follow-up</i>				0.09
No	754 (15)	4367 (85)	5121	
Prior to Wave 2	193 (17)	910 (83)	1103	
Prior to Wave 3	127 (19)	558 (81)	685	
<i>Deployment to SWA before 2000</i>	307 (14)	1931 (86)	2238	0.04
<b>Behavioral factors</b>				
<i>Smoking status</i>				<0.01
Nonsmoker	415 (14)	2638 (86)	3053	
Past smoker	409 (16)	2160 (84)	2569	
Current smoker	250 (20)	1037 (80)	1287	
<i>Drinking status</i>				<0.01
Abstinence	86 (10)	867 (90)	953	
Low risk, no problem	92 (8)	1072 (92)	1164	
Risky drinking	896 (19)	3896 (81)	4792	
<i>Trouble sleeping</i>	461 (20)	1931 (80)	2392	<0.01
<b>Mental health conditions</b>				
Depression	61 (32)	152 (68)	213	<0.01
Binge eating	274 (20)	1102 (80)	1376	<0.01
Panic/anxiety disorder	63 (26)	188 (74)	251	<0.01
PTSD (DSM-IV & PCL-C ≥50)	60 (28)	153 (72)	213	<0.01
<b>Physical health</b>				
<i>Physical components summary</i>				0.06
1–15 Percentile	180 (19)	839 (81)	1019	
16–85 Percentile	751 (15)	4280 (85)	5031	
86–100 Percentile	143 (17)	716 (83)	859	
<b>Life stressors</b>				
<i>Life stressor events</i>				0.01
None	516 (15)	2930 (85)	3446	
1 event	385 (16)	2174 (84)	2559	

Table 1 (Continued)

	Relapsed to problem drinking* N (%)	Remission ** N (%)	Total N (%)	p-Value <sup>c</sup>
More than 1 event	173 (21)	731 (79)	904	
Sexual assault	13 (21)	39 (79)	52	0.42

Abbreviations: DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; PCL-C, PTSD Checklist-Civilian Version; PCS, physical component summary; PTSD, posttraumatic stress disorder.

<sup>a</sup> Demographics and military service variables were taken at baseline unless otherwise stated; marital status, behavioral factors, mental health conditions, physical health, and life stressors were taken at Wave 2 survey.

<sup>b</sup> Weighted to account for sampling strategy. Personnel deployed to Southwest Asia, Bosnia, and Kosovo from 1998 to 2000, Reservists, and women were oversampled.

<sup>c</sup> Chi-square test comparing frequencies across relapse status.

\* Relapse was defined as report of ≥1 past-year alcohol-related problem on the validated Patient Health Questionnaire at the second follow-up (2007–2008).

\*\* Remission was defined as non-endorsement of any past-year alcohol-related problems at the first and second follow-up.

significantly different between remittent problem drinkers who relapsed and those who did not (Table 1). Regarding military characteristics, relapse was most common among members of the Army and Marines, Reservists/National Guard, junior enlisted members, those deployed with combat exposure, and those deployed to Southwest Asia, Kosovo, or Bosnia before 2000 (Table 1).

Associations between exposures and relapse resulting from each iterative set of models are presented in Table 2, columns 2–4, corresponding to adjustment for sampling characteristics, additional demographics and Wave 2 drinking status (column 2), adding military characteristics (column 3); and mutual adjustment for all exposures (column 4). Relative to their respective referent categories, the first set of models identified being never married, having some college or less, being in the Reserve/National Guard, separating from the military prior to Waves 2 or 3, being deployed with combat exposure, being a past or current smoker, reporting risky drinking and trouble sleeping, screening positive for any mental health condition, being in the lowest category of physical health, and report >1 life stressor or sexual assault to be associated with significantly higher odds of relapse at Wave 3 (Table 2, column 2). Serving in the Air Force, having multiple deployments, and being deployed without combat exposure or to Southwest Asia, Bosnia, or Kosovo before 2000 were associated with lower odds of relapse relative to the respective referent categories (Table 2, column 2). After adjustment for military service characteristics, education, deployment without combat exposure or to Southwest Asia, Bosnia, or Kosovo before 2000, and report of past smoking or sexual assault were no longer significantly associated with relapse, and the lower risk associated with being in the Air Force was slightly attenuated (Table 2, column 3). After adjustment for all other exposures, associations between relapse and both life stressors and physical health were no longer significant, but male gender was associated with higher odds of relapse (Table 2, column 3).

After full adjustment, risky (relative to low risk) drinking was the strongest predictor of relapse to problem drinking (Table 2, column 4). Male gender, current (relative to never) smoking, report of trouble sleeping, and screening positive for any mental health condition were also associated with higher risk of relapse. Additionally, several military service characteristics were significantly associated with higher risk of relapse (Table 2, column 4). These included service component, with Reservists and National Guard members having higher odds of relapsing compared with their active-duty counterparts, separation from the military at any time during follow-up, and deployment with combat exposure relative to no deployment. Point estimates of higher risk associated with these characteristics ranged from 30% (deployment with combat exposure) to 67% (Reserve/National Guard member) (confidence intervals presented in Table 2, column 4). However, several military characteristics were associated with a lower risk of relapse, including multiple deployments (versus one or none) and service in the Air Force relative to the Army (Table 2, column 4).

#### 4. Discussion

This is the first study to describe the prevalence and correlates of relapse to problem drinking over time among a prospective cohort of military personnel. This study indicates that one sixth of military personnel with remittent problem drinking relapsed within 3 years and identifies particular military subpopulations at higher risk of relapse. Specifically, those serving in the Reserves/National Guard, those who separated from the military, and those who deployed with combat exposure had higher risk of relapse, as did those with other risky health behaviors and mental health conditions.

The prevalence of relapse identified in the present study – 16% – is low relative to previous estimates in the general population (26%; Dawson et al., 2007) and samples previously treated for alcohol use disorders (McKay, 1999; McKay et al., 2006; Moos and Moos, 2006; Walitzer and Dearing, 2006; range, 40–80%). However, problem drinking may be particularly costly among military personnel via decreased performance (Frone, 2006; Harwood et al., 2009; Lamond and Dawson, 1999; O'Brien and Lyons, 2000), adverse physical health outcomes (Harris et al., 2009; Williams et al., 2012), comorbid mental health disorders (Milliken et al., 2007), and risk of suicide (LeardMann et al., 2013). Remitting and relapsing problem drinking may be particularly risky among military personnel because it may reflect disordered drinking, which is often difficult to control and change once developed (National Center on Addiction and Substance Abuse, 2012).

This study's findings that risky health behaviors, particularly risky drinking and smoking, and screening positive for mental health conditions are correlates of relapse are consistent with studies in the general population and treatment samples (Dawson et al., 2007; McKay, 1999; McKay et al., 2006; Moos and Moos, 2006; Walitzer and Dearing, 2006). However, among military personnel, several service characteristics were also predictive of relapse. The strongest predictor of relapse was membership in the Reserves/National Guard, with an estimated ~67% higher risk of relapse compared with active-duty members. This may reflect lower risk aversion among Reserve/Guard personnel who generally have other non-military occupations. Alternatively, due to recent conflicts in Iraq and Afghanistan, many Reserve/Guard personnel may have returned to alcohol as a coping mechanism as a result of being less prepared for deployment than their active-duty counterparts (Jacobson et al., 2008; Milliken et al., 2007). Other factors, such as lack of unit support during deployment and lack of support from fellow service members after returning home from deployment, could also have contributed to the increased risk observed among Reserve/Guard personnel.

Military personnel deployed with combat exposure were estimated to be 30% more likely to relapse to problem drinking than those not deployed. These findings add to an increasing literature highlighting combat exposure as a risk factor for problem drinking (Bray et al., 2013; Gallaway et al., 2013; Hoge et al., 2004; Jacobson et al., 2008; Wilk et al., 2010) and other mental health conditions (Mitchell et al., 2012). Interestingly, however, participants in this

**Table 2**

Associations between problem drinking relapse\* and demographic, military, behavioral, and health factors.

	Adjusted for demographics, Wave 2 drinking behavior, prior deployment, and service component	Adjusted for demographics, Wave 2 drinking behavior, and military characteristics	Mutually adjusted for all covariates
	OR (95% CL)	OR (95% CL)	OR (95% CL)
<b>Demographics</b>			
Sex			
Female	1.00	1.00	1.00
Male	1.15 (0.96–1.38)	1.10 (0.91–1.33)	<b>1.22 (1.00–1.48)</b>
Race/ethnicity			
White, non-Hispanic	1.00	1.00	1.00
Black, non-Hispanic	0.88 (0.67–1.14)	0.87 (0.66–1.13)	0.87 (0.67–1.15)
Hispanic	1.19 (0.91–1.56)	1.21 (0.92–1.58)	1.19 (0.90–1.56)
Other	1.20 (0.94–1.53)	1.17 (0.91–1.52)	1.21 (0.93–1.57)
Age category (years)			
17–24	1.15 (0.94–1.41)	1.08 (0.87–1.34)	1.08 (0.87–1.34)
25–34	1.00	1.00	1.00
35–44	1.01 (0.86–1.19)	0.98 (0.81–1.17)	0.95 (0.79–1.15)
>44	0.82 (0.65–1.03)	0.82 (0.64–1.05)	0.80 (0.62–1.02)
Marital status			
Married	1.00	1.00	1.00
Never married	<b>1.25 (1.05–1.49)</b>	<b>1.20 (1.01–1.44)</b>	<b>1.23 (1.03–1.47)</b>
Divorced or widowed	1.15 (0.91–1.45)	1.12 (0.87–1.42)	1.09 (0.86–1.39)
Education			
Bachelor's degree or higher	1.00	1.00	1.00
Some college or less	<b>1.30 (1.10–1.53)</b>	1.10 (0.87–1.39)	1.07 (0.85–1.35)
<b>Military service</b>			
Service branch			
Army	1.00	1.00	1.00
Navy/Coast Guard	0.91 (0.75–1.09)	0.97 (0.80–1.17)	1.01 (0.84–1.22)
Marines	1.18 (0.89–1.57)	1.18 (0.86–1.58)	1.20 (0.90–1.61)
Air Force	<b>0.66 (0.55–0.79)</b>	<b>0.74 (0.61–0.89)</b>	<b>0.78 (0.64–0.94)</b>
Service component			
Active duty	1.00	1.00	1.00
Reserve/Guard	<b>1.40 (1.21–1.62)</b>	<b>1.60 (1.35–1.88)</b>	<b>1.67 (1.41–1.97)</b>
Occupation			
Other	1.00	1.00	1.00
Combat specialist	1.09 (0.92–1.28)	1.06 (0.90–1.26)	1.07 (0.90–1.27)
Health care	1.01 (0.79–1.29)	1.01 (0.79–1.29)	1.01 (0.79–1.29)
Paygrade			
Junior enlisted	1.00	1.00	1.00
Senior enlisted	0.99 (0.82–1.20)	1.01 (0.83–1.23)	1.07 (0.88–1.30)
Officer	0.81 (0.62–1.07)	0.83 (0.63–1.09)	0.92 (0.69–1.22)
Military separation			
No	1.00	1.00	1.00
Prior to Wave 2	<b>1.48 (1.23–1.78)</b>	<b>1.38 (1.14–1.68)</b>	<b>1.31 (1.08–1.59)</b>
Prior to Wave 3	<b>1.62 (1.30–2.03)</b>	<b>1.52 (1.22–1.90)</b>	<b>1.47 (1.17–1.84)</b>
Multiple deployments			
Yes	<b>0.73 (0.60–0.88)</b>	<b>0.74 (0.59–0.93)</b>	<b>0.76 (0.61–0.95)</b>
Combat deployment at Wave 2			
Not deployed	1.00	1.00	1.00
Deployed without combat exposure	<b>0.74 (0.60–0.92)</b>	0.95 (0.75–1.20)	0.96 (0.76–1.22)
Deployed with combat exposure	<b>1.20 (1.01–1.44)</b>	<b>1.39 (1.14–1.71)</b>	<b>1.30 (1.06–1.60)</b>
Deployment to SWA before 2000	<b>0.85 (0.72–0.99)</b>	0.95 (0.81–1.12)	0.95 (0.80–1.12)
<b>Behavioral factors</b>			
Smoking status			
Nonsmoker	1.00	1.00	1.00
Past smoker	<b>1.16 (1.00–1.35)</b>	1.12 (0.96–1.31)	1.12 (0.96–1.30)
Current smoker	<b>1.33 (1.11–1.59)</b>	<b>1.27 (1.05–1.52)</b>	<b>1.26 (1.05–1.51)</b>
Drinking status			
Low risk, no problem	1.00	1.00	1.00
Abstinence	1.08 (0.79–1.47)	1.03 (0.76–1.41)	1.01 (0.74–1.38)
Risky drinking	<b>2.49 (1.98–3.13)</b>	<b>2.51 (2.00–3.16)</b>	<b>2.47 (1.96–3.12)</b>
Trouble sleeping	<b>1.54 (1.34–1.76)</b>	<b>1.46 (1.27–1.67)</b>	<b>1.32 (1.14–1.53)</b>
<b>Mental health conditions</b>			
Any report of depression, binge eating, Panic/anxiety, or PTSD	<b>1.61 (1.39–1.86)</b>	<b>1.53 (1.32–1.77)</b>	<b>1.40 (1.20–1.63)</b>
<b>Physical health</b>			
Physical components summary			
1–15 Percentile	<b>1.32 (1.10–1.59)</b>	<b>1.23 (1.02–1.48)</b>	1.05 (0.87–1.28)
16–85 Percentile	1.00	1.00	1.00
86–100 Percentile	1.10 (0.90–1.34)	1.12 (0.92–1.37)	1.09 (0.89–1.33)
<b>Life stressors</b>			
Life stressor events			
None	1.00	1.00	1.00
1 event	0.99 (0.86–1.15)	0.97 (0.84–1.12)	0.94 (0.81–1.09)
More than 1 event	<b>1.35 (1.12–1.64)</b>	<b>1.27 (1.04–1.55)</b>	1.09 (0.89–1.35)
Sexual assault	<b>2.01 (1.04–3.89)</b>	1.85 (0.95–3.59)	1.55 (0.79–3.06)

\* Problem drinking relapse was defined as report of ≥1 past-year alcohol-related problem on the validated Patient Health Questionnaire at the second follow-up (2007–2008).

study who reported multiple deployments were at lower risk of relapse compared to those without. It could be that participants who are qualified for multiple deployments are a select population of particularly healthy and resilient personnel (i.e., those who are high-functioning, able to pass deployment screenings, and do not exhibit alcohol problems). This would be consistent with previous studies describing a "healthy warrior effect" (Haley, 1998; Larson et al., 2008). The lower odds of relapse observed in members of the Air Force compared with Army personnel are consistent with previous studies demonstrating lower risk of mental health outcomes among Air Force compared with Army members (Milliken et al., 2007; Riddle et al., 2007). These findings may be attributable to social and occupational features of these branches. Expectations of Air Force personnel regarding problem drinking may be particularly rigid due to the rigor of their jobs and the requirement to be ready for flight status.

The overall rate of relapse identified in this study suggests that, as recommended by the DoD and Department of Veterans Affairs (VA; VA Office of Quality and Performance, 2009), routine interventions with and monitoring of military personnel with problem drinking are appropriate. Abstinence is generally recommended for those with remittent problem drinking, because, consistent with findings from this study, continued use increases relapse risk (Dawson et al., 2007). While routine intervention and ongoing monitoring for those with risky and problem drinking are historically difficult to implement in care, the VA has had some implementation success (Lapham et al., 2012; Moyer and Finney, 2010; Williams et al., 2011). However, availability of these services is variable across DoD settings, and, as highlighted in a 2012 IOM report (Institute of Medicine, 2012), there is substantial fragmentation of care. In addition to the need for streamlining care, the report discussed the need for interventions that temper stigma for military personnel with remittent problem drinking (Ames et al., 2014; Institute of Medicine, 2012; Milliken, 2011).

While efforts to prevent relapse are needed in the overall military population with remittent problem drinking, this study identified military and non-military service characteristics that could help target populations in most need of intervention aimed at interrupting the pathway to relapse. This study builds on a previous Millennium Cohort investigation that assessed predictors of initiating problem drinking among service members (Jacobson et al., 2008). The same predictors of initiating problem drinking also contribute to higher odds of problem drinking relapse in this sample, thus strengthening the argument for intervention in these military subpopulations, including members of the Reserve/Guard, those who deploy and have combat exposure, and those with comorbid mental health conditions. Because the prevalence of mental health conditions (Bray et al., 2010; Grossbard et al., 2013; Hawkins et al., 2010; Milliken et al., 2007; Mitchell et al., 2012) is substantial among recently returned soldiers and veterans, interventions may be particularly important in mental healthcare settings.

This study has a number of limitations. First, full baseline alcohol assessments were only completed among participants who reported drinking at least 12 drinks in the year prior to survey. Due to this, and because approximately half of people who meet CAGE criteria for problem drinking are non-drinkers (Samet and O'Connor, 1998), we were unable to use the CAGE to identify remittent problem drinkers at baseline with precision. Thus, we were unable to maximize the utility of these longitudinal data by assessing relapse at Wave 2. Second, no diagnostic assessment for alcohol use disorders was completed, which would have facilitated a more focused study of the prevalence and correlates of relapse to alcohol use disorders. Thus, the present study assessed problem drinking because it is associated with a high likelihood of alcohol use disorders and the available validated measures assess domains that overlap with those of diagnostic criteria for

alcohol use disorders (Buchsbaum et al., 1991; Ewing, 1984; Fiellin et al., 2000; Spitzer et al., 1999). In addition, past-year problem drinking was assessed in approximately three year intervals. Therefore, it is possible that participants who cycled through relapse and remittance in the timeframe between responses were misclassified. However, the effect of the misclassification bias is likely non-differential, given no indication that military or non-military characteristics were related to the timing of surveys. Lack of treatment data for alcohol use disorders is also a limitation, since those who seek treatment may differ in important ways from those who do not, and residual confounding may exist. Further, it is possible that correlates of relapse may be modified by treatment status. However, the vast majority of people with alcohol use disorders, including military personnel for whom barriers to care such as stigma may be increased (Institute of Medicine, 2012; Milliken, 2011), never seek treatment. Thus, this is unlikely to substantially impact findings. There are additionally limitations related to several exposure measures. We were not able to identify mild traumatic brain injury, which is associated with higher risk of problem drinking (Miller et al., 2013). Additionally, because combat exposure was defined as endorsement of witnessing traumatic experiences during a 3 year period and then categorized as combat exposure if it overlapped with deployment reported at Wave 2, combat exposure was only assessed among those people who also deployed during the same 3 year period and may have been misclassified. Also, while it has been used in previous studies (Boyko et al., 2013; Gehrman et al., 2013), the measure of trouble sleeping used has not been validated. Finally, similar to other large longitudinal surveys, generalizability may be limited by response bias. A previous study in a similar subsample of Millennium Cohort participants assessed non-response (Jacobson et al., 2008) and identified older age, greater education, and being married as predictors of response. Initial analyses in the present study demonstrated small but significant differences in many characteristics by response. There was a slightly higher proportion (73% vs 69%) of potentially eligible participants reporting risky drinking at Wave 2 who did not respond to the Wave 3 survey, compared with those included in the present study. Given the strong association between risky drinking at Wave 2 and relapse, we may not have captured all cases who relapsed to problem drinking. While the overall influence of response bias on results of the current study is unknown, the characteristics of Wave 3 non-responders were similar to a previous report of non-responders in the first enrollment panel of the Millennium Cohort, the findings of which suggested that analyses in the recruited and retained cohort are unlikely to be substantially biased by non-response (Littman et al., 2010).

This study described relapse among military personnel in remittance of problem drinking and prospectively evaluates correlates of relapse. Findings suggest that one sixth of military personnel with remittent problem drinking experience relapse approximately 3 years later and support the implementation of conducting routine monitoring of identified problem drinking among military personnel and veterans. This practice is consistent with current clinical recommendations. Military personnel with remittent problem drinking who do not abstain from alcohol use during remittance, Reservists or National Guard members, those who are deployed with combat exposure, and those who have separated from the military may benefit from targeted prevention and treatment strategies.

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## Contributors

All authors contributed to study design, protocol development, and data interpretation and participated in iterative review of data analysis and presentation. E. Williams led the project, helped conceive and design the study, and led the interpretation of results and writing the paper. M. Frasco and A. Nagel completed the analyses, aided in the interpretation of results and aided in the revising of the paper. I. Jacobson, C. Maynard, and A. Littman contributed substantially to the study design and execution, as well as revising the paper. A. Seelig helped in data collection and cleaning of the analytic dataset as well as manuscript preparation, revisions, and submission. In their respective roles as former principal investigator of the Millennium Cohort Study and principal investigator of the present study, N. Crum-Cianflone and E. Boyko guided all study design, analysis, interpretation and presentation. All authors contributed to and have approved the final manuscript.

## Conflict of interest

None declared.

## Ethical approval

This research was conducted in compliance with all applicable federal regulations governing the protection of human subjects (Protocol NHRC.2000.0007).

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.drugalcdep.2014.12.031>.

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